

An Overview of Ecological Studies of Wildlife Potentially Impacted by the Kingston Ash Spill

T. H. Henry, Tennessee Valley Authority
W. A. Hopkins, Virginia Polytechnic Institute and State University

INTRODUCTION

The Tennessee Valley Authority (TVA) is a multi-purpose federal agency that on December 22, 2008 suffered a retaining wall failure at the TVA Kingston Fossil Plant in Roane County, Tennessee. This event released approximately 5.4 million cubic yards of coal ash into the Emory River.

TVA and cooperators are assessing impacts of the spill to wildlife resources in the area. Groups of wildlife included in these studies include piscivorous, insectivorous, and herbivorous birds; spring breeding amphibians; aquatic reptiles; and terrestrial and semi-aquatic mammals. These studies will serve as the foundation for upcoming work that will determine whether key ecological receptors have experienced any adverse biological effects from exposure to trace elements from the ash spill.

OBJECTIVES

The goal of these initial studies is to document whether the ash spill has exposed wildlife in the region to trace elements.

Objective 1: Identify wildlife resources near the Kingston ash spill.

Objective 2: Initiate studies to determine existing levels of trace elements in multi-taxonomic groups of wildlife at Kingston.

METHODS

Objective 1: TVA biologists interviewed local biologists, and used aerial photography, published reports and the TVA Regional Natural Heritage Project database to identify habitats and wildlife resources in the region. Field surveys were performed to identify local resources.

Objective 2: Once wildlife resources were identified, species across multiple taxons were selected based upon their availability and potential exposure by various ecological pathways to 26 trace elements.

- Wildlife species selected include Osprey (*Pandion haliaetus*), Great Blue Heron (*Ardea herodias*), Tree Swallow (*Tachycineta bicolor*), Upland Chorus Frog (*Pseudacris feriarum*), Spring Peeper (*P. crucifer*), American Toad (*Bufo americanus*), Snapping Turtle (*Chelydra serpentina*), Common Musk Turtle (*Sternotherous ordoratus*), Raccoon (*Procyon lotor*) and Muskrat (*Ondatra zibethicus*).

- Elements tested include Aluminum (Al), Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cadmium (Cd), Calcium (Ca), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Magnesium (Mg), Manganese (Mn), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Potassium (K), Selenium (Se), Silver (Ag), Sodium (Na), Strontium (Sr), Thallium (Tl), Vanadium (V), and Zinc (Zn).

- Tissues tested include contents of eggs (birds), whole body (amphibian and bird nestlings), blood (turtles and mammals), hair and organs (mammals).

- Emphasis was placed upon working with university partners to provide project oversight and third-party verification.

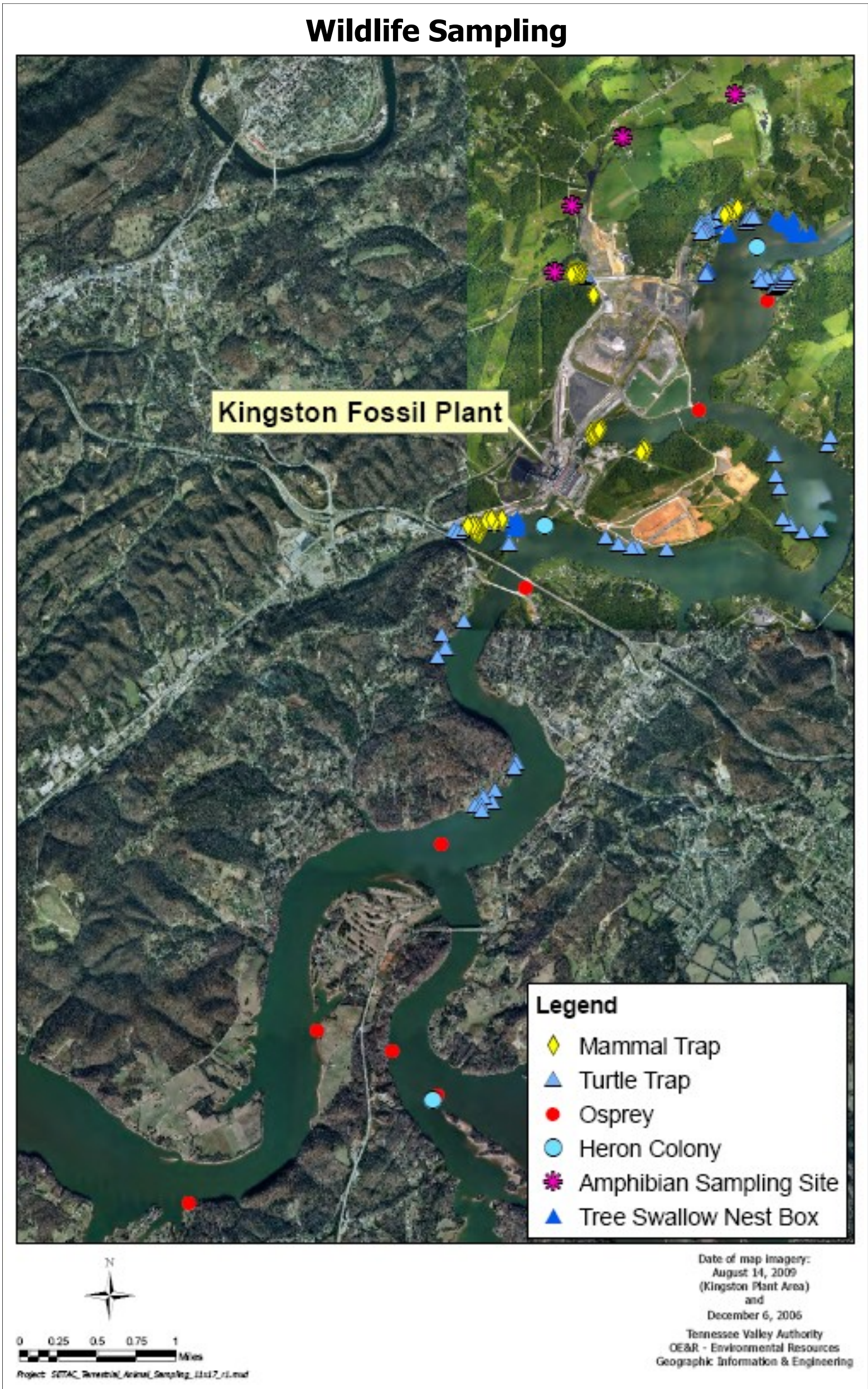


Figure 1. Study site and trapping localities at Kingston Fossil Plant, Roane County, Tennessee.



Measuring an osprey egg collected from a nest on the Emory River.



Dr. Bill Hopkins training technicians how to measure and handle turtles at the Kingston Ash Spill.



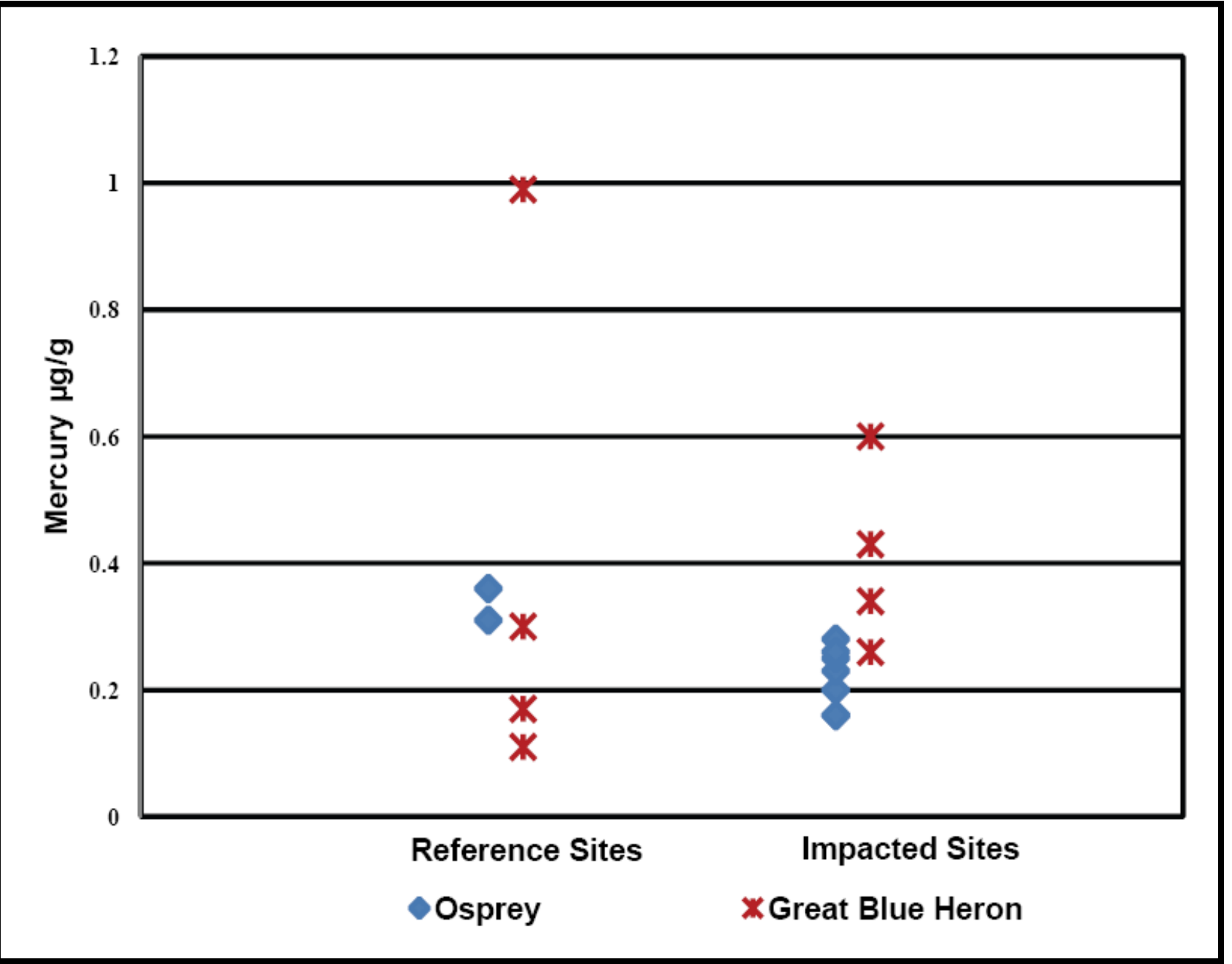
Osprey on nest at Kingston Fossil Plant intake.

RESULTS - OSPREY

- Nine osprey eggs were collected from various sites along the Emory, Clinch and Tennessee Rivers (Figure 1).
- Although sample sizes were small for this initial investigation, there were no striking differences in trace element concentrations between reference and impacted sites in eggs from osprey.
- Only 8 of 25 metals were detected in osprey eggs. As, Cd, and Pb were below detection limits (mean detection limit $<0.57 \pm 0.04 \mu\text{g/g}$). Mn and Fe was only detected in 1 and 2 samples, respectively. Ca, Hg, K, Se, Na, and Zn were detected in all osprey samples.

- In general, Hg and Se concentrations were low and similar between sites (Figs. 2 and 3). Average Hg concentration was $0.25 \pm 0.02 \mu\text{g/g}$, average Se concentration was $1.96 \pm 0.12 \mu\text{g/g}$.

Figure 2. Comparison of Mercury values observed in fish-eating birds at Kingston.

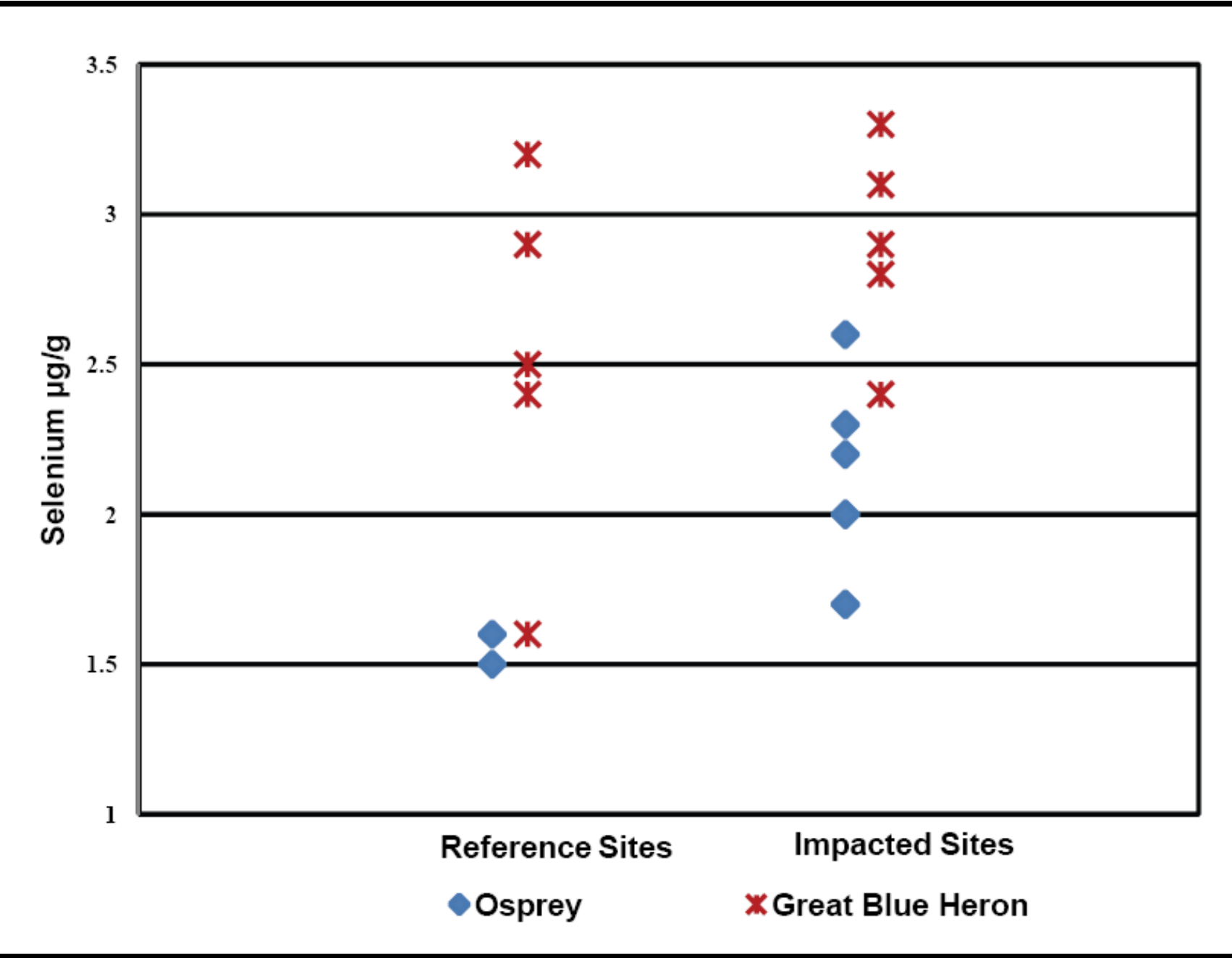


Harriman Utilities lineman sampling heron eggs.

RESULTS - HERONS

- Ten eggs were collected from two sites (Figure 1).
- Eleven of 25 metals were detected in great blue herons. As, Cd and Pb were below detection limits (mean detection limit $<0.53 \pm 0.03 \mu\text{g/g}$). Ba, Mg, Mn, and Ni were detected in 6, 5, 5, and 1 of 10 samples; respectively. Ca, Cu, Hg, K, Se, Na, and Zn were detected in all samples.
- Hg and Se concentrations were low and similar between all sites. Average Hg concentration was $0.38 \pm 0.08 \mu\text{g/g}$, average Se concentration was $2.71 \pm 0.16 \mu\text{g/g}$ (Figs. 2 and 3).

Figure 3. Comparison of Selenium values observed in fish-eating birds at Kingston.



American toad captured at sample site.

RESULTS - FROGS AND TOADS

- Seventy-six amphibians were collected from various sites (Figs. 1 and 6). Sixty-six specimens came from impacted sites, while 10 specimens were collected at a reference site.
- Seventeen of 25 metals were detected in amphibians, there was little difference in detection of metals between species. Cd concentrations in amphibians were below detection limits (mean detection limit $<0.40 \pm 0.01 \mu\text{g/g}$). As was detected in 17 of 76 samples (mean = $1.80 \pm 0.39 \mu\text{g/g}$). Pb was detected in 30 of 76 samples (mean = $0.84 \pm 0.08 \mu\text{g/g}$). Hg was detected in 22 of 76 samples (mean = $0.10 \pm 0.01 \mu\text{g/g}$). Se was detected in all samples (mean = $1.59 \pm 0.05 \mu\text{g/g}$).
- Concentrations of additional elements were also elevated in some samples; including Ba (mean = $63.77 \pm 3.73 \mu\text{g/g}$), Al (mean = $341.58 \pm 102.55 \mu\text{g/g}$), Fe (mean = $221.44 \pm 25.59 \mu\text{g/g}$), and Ni (mean = $1.75 \pm 0.76 \mu\text{g/g}$). However, concentrations of Hg and Se were lower in amphibians (Figs. 4 and 5).

Figure 4. Comparison of Mercury values observed in amphibians at Kingston.

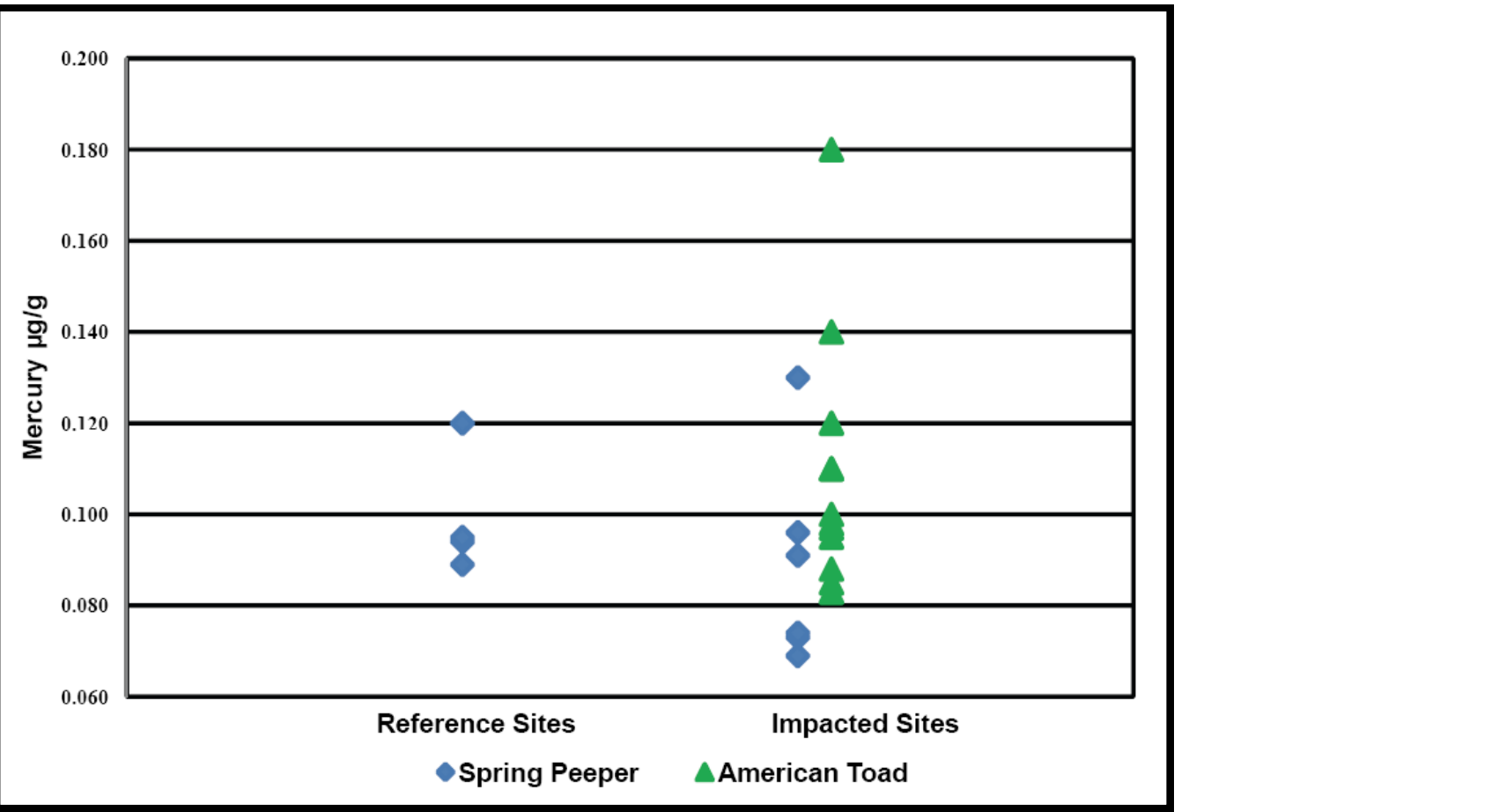
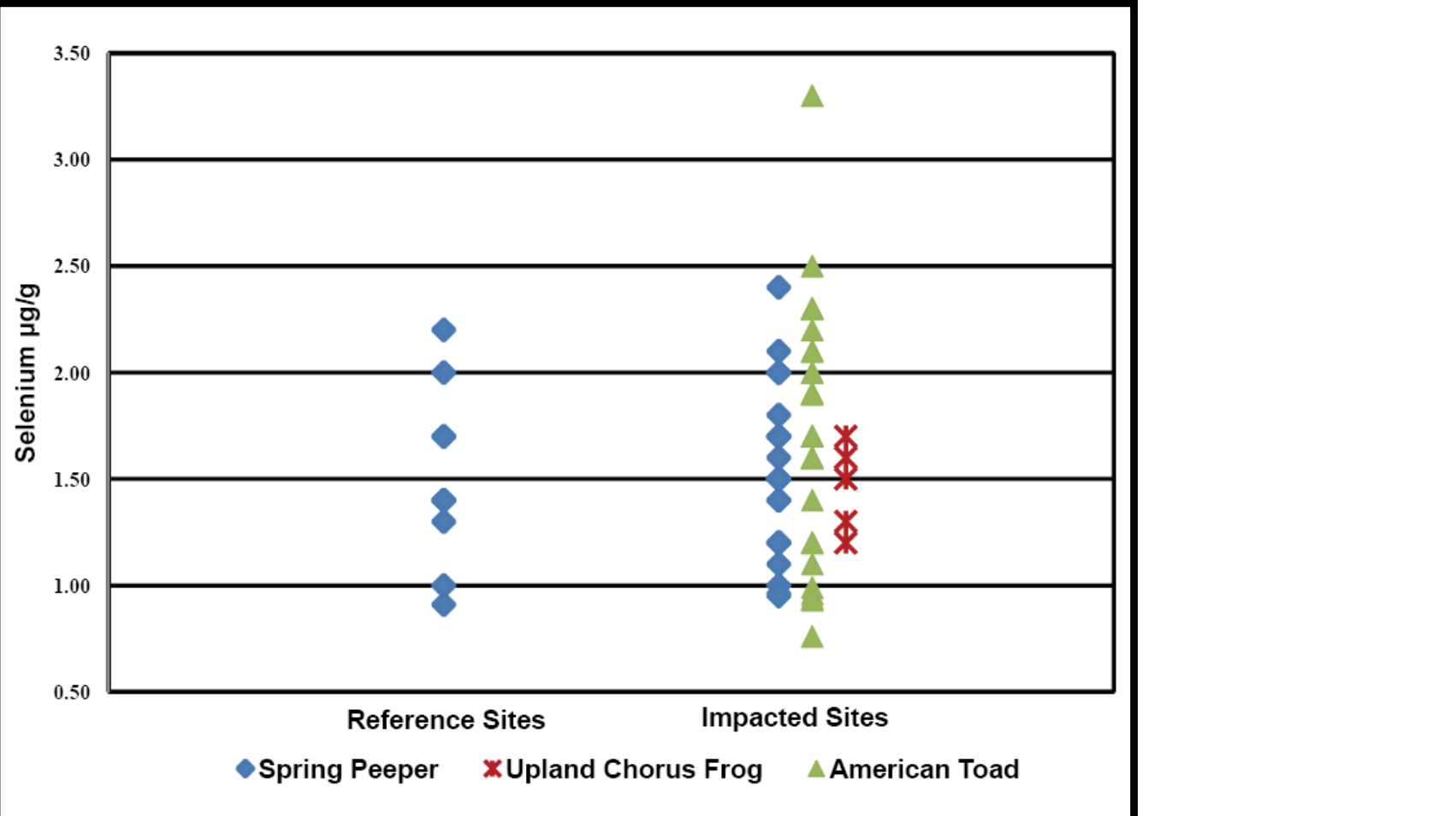


Figure 5. Comparison of Selenium values observed in amphibians at Kingston.



REFERENCE SITES AND OVERVIEW MAP

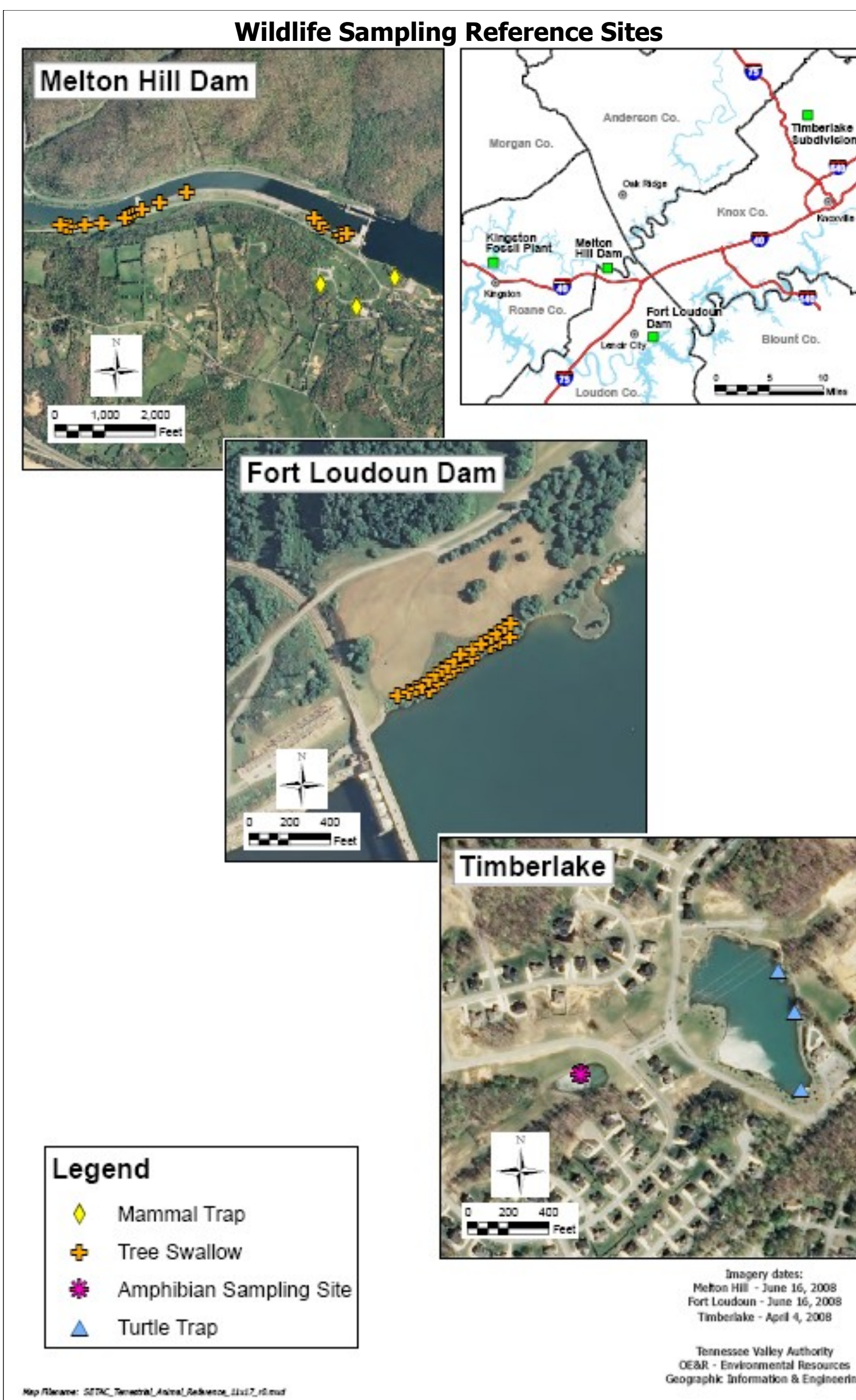


Figure 6. Reference sites at Melton Hill Dam, Fort Loudoun Dam, and Timberlake.

DISCUSSION

Initial results suggest that most species examined have not experienced widespread exposure to trace elements derived from coal ash. While trace elements were detected in fish-eating birds, levels were low, especially in osprey. A possible explanation for these observations relates to the relatively short (~ 4 months) amount of time that had elapsed between the spill and the onset of breeding activity at the site, providing little time for accumulation in fish prey.

There was little difference in concentrations of trace elements observed in heron eggs collected at the spill and those collected at a reference site. One heron egg sampled from the Emory River near the spill had elevated concentrations of Ba ($1.0 \mu\text{g/g}$), Ni ($3.0 \mu\text{g/g}$), and Cu ($18.5 \mu\text{g/g}$) relative to all of the other eggs sampled (many of which were below detection). It is unlikely that these concentrations are a cause for concern because they fall within the broad range reported in the literature from other bird species (e.g., Mora, 2003 and references therein).

Concentrations of trace elements were low in amphibians; however, the combination of trace elements accumulated by amphibians was more complex than those observed in bird eggs. In some cases (i.e., toads), element profiles were similar to those observed at other sites contaminated with coal ash. Additional studies will expand sampling efforts of this and other taxonomic groups to determine whether adverse effects are occurring in these terrestrial organisms.

REFERENCE

Mora, M.A. 2003. Heavy metals and metalloids in egg contents and eggshells of passerine birds from Arizona. *Environmental Pollution* 125:393-400.

PROGRESS OF OTHER STUDIES



Tree swallow monitoring was initiated this year and results are presented concurrently in this session. TVA is examining the relationship between Canada geese (*Branta canadensis*) and grasses planted on the ash spill for erosion control and dust suppression. The investigation will examine trace element concentrations in grass and the eggs of resident geese. Blood samples have been collected from snapping and common musk turtles at various locations (Figs 1 and 6), sample collection is completed for the year and results are being analyzed. The University of Tennessee is completing an analysis of raccoons along the shoreline at the ash spill. These samples will be analyzed over the next few months.

ACKNOWLEDGEMENTS

The authors thank Wes James, Ken Weisz, Holly LeGrand, Liz Burton, Bo Baxter, David Wilson, Burline Pullin, Staff at Kingston Fossil Plant, TVA Police, TVA Reality Services, Environmental Standards, Inc., Pace Analytical Services, Inc., and Restoration Services for their assistance with collecting and processing samples for these projects. Personnel from Harriman Utilities, Kingston Fossil Plant and TVA Linemen very skillfully collected eggs from nests in trees and on transmission line structures. Personnel from USFWS and TWRA were also extremely helpful with permitting, study design and field assistance.